

The SACCESS network for COVID-19 wastewater surveillance: a national collaboration for public health responsiveness

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The agility of the SACCESS network in the context of the COVID-19 crisis enabled its formation and response to challenges in a short space of time.

The global COVID-19 pandemic has highlighted the need for stronger health systems, and the potential role of networks in this strengthening. In the early phase of the pandemic, wastewater surveillance as a predictive and monitoring tool for COVID-19 was identified internationally. This realisation alerted researchers in South Africa, who through various pathways formed the South African Collaborative COVID-19 Environmental Surveillance System (SACCESS) network. Made up of a wide range of actors, SACCESS has progressed rapidly in a field with many unknowns.

This qualitative case study aimed to explore the lessons that the SACCESS network provides in terms of network governance and bottom-up collaboration, and to apply this to health system strengthening. Key informant interviews (n=12) were conducted with purposively selected members of the SACCESS network. Data were analysed thematically.

Four main themes emerged: the enabling factors of network formation in the time of COVID-19; the importance of relationships; strengths and challenges of an informal network; and lessons for building health systems. Several lessons emerged for health system strengthening in the time of COVID-19 and beyond: the importance of informal networks, and bottom-up collaboration; recognition that individuals, not institutions, are key in informal networks; and the time required for building trust.

It is important for network governance to be flexible as it evolves, particularly in times of crisis. It may be difficult for an informal network to interact with more formal, bureaucratic structures. There is need to explore how to create a recognised role and space for informal networks, such as the SACCESS network, to move towards stronger health systems.

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Introduction

Health systems are complex, adaptive systems comprising a variety of individuals, organisations and networks with different values and interests.¹ The global COVID-19 pandemic has highlighted the need for responsive health systems, particularly the role that networks can play in this strengthening.² A network is a set of organisations (nodes), and the relations (ties) among them that serve as channels through which communication, resources and referrals flow.³ The capacity to strengthen health systems through networks has been shown.⁴ A current gap in health system strengthening research is that of identifying the optimal approach to developing and supporting network collaborations in low- and middle-income countries (LMICs).⁴

The COVID-19 pandemic is a public health emergency like no other. Network collaboration has been shown to drive innovation in times of crisis because multifaceted problems arise which extend beyond the capabilities of a single actor.⁵ Research has shown that the COVID-19 pandemic is not amenable to top-down solutions, and collaboration between different government agencies and non-governmental actors (businesses, knowledge centres, non-profit organisations, and organised or individual citizens) is essential.⁶ There is need to design bottom-up 'learning health systems' in response to COVID-19⁷, but bottom-up solutions have been neglected in scholarly and public conversations.⁸

An initial priority during the pandemic was the early identification of infection trends in communities, and tracking of national epidemic trajectories to support and assess the effect of control measures. In the early phase of the pandemic, international reports of the detection of SARS-CoV-2 RNA fragments in wastewater (WW) were published.^{9,10} Monitoring of WW through wastewater-based epidemiology (WBE) has previously focused on monitoring of drugs and other communicable disease pathogens (typically those that are faeco-orally transmitted), and has increasingly been recognised as a potentially critical

predictive and surveillance tool during the COVID-19 pandemic.^{10,11} Global literature has highlighted that expanding the usefulness of WBE will require national networks, and collaboration among a range of scientists across disciplines.¹²

South Africa has experienced a heavy COVID-19 impact and, as of August 2021, has had significantly more confirmed cases and deaths than any other African country.¹³ The recognition of the utility of WBE for COVID-19 led researchers in the Western Cape (WC), where the first wave began in South Africa, to establish a local network. Other organisations across the country started similar work, and the WBE network subsequently expanded to form the South African Collaborative COVID-19 Environmental Surveillance System (SACCESS) network. The network comprises a range of actors including university researchers, municipal sanitation and public health officials, Provincial Health Department officials, and representatives of the National Institute for Communicable Diseases (NICD), private laboratories, and research councils and commissions. It includes participants from across South Africa in five provinces – Eastern Cape (EC), Gauteng (GP), KwaZulu-Natal (KZN), North West (NW), Western Cape (WC) and multiple local municipalities.

SACCESS was formed in a spontaneous way and has provided a unique opportunity for organisations to share knowledge and resources. The network has enabled the establishment of connections between members, and has achieved many commendable outputs in just one year (Table 1). Notably, a global review found that WBE for COVID-19 is inequitably concentrated in high-income countries (HICs), with poor or inconsistent data-sharing which limits the potential for appropriate public health interventions.¹⁴ The experience of the SACCESS network may therefore have important lessons for the COVID-19 response and health systems, particularly in LMICs. This study aimed to investigate the strengths and challenges of the SACCESS network, centred on the following primary research question: 'What can be learnt from how the SACCESS network formed and operated during COVID-19 that might inform wider application to strengthen the health system in South Africa and in other contexts?'

Table 1: List of achievements of SACCESS network members to date

Establishment of a national dashboard at the NICD for results from 21 WW sites
Detection of COVID-19 in WW in six provinces in South Africa
Preliminary establishment of routine surveillance structures using WBE in WC and KZN
Piloting of protocols for surveillance of high-risk populations in defined institutions (prisons, homes for the elderly, residences)
Representation on the Ministerial Advisory Sub-committee for Surveillance
Presentation to various significant fora, e.g. South African Local Government Association (SALGA)
Development of a pilot sampling strategy for fine unit sampling in small areas (from pump-station to manhole)
First detection of COVID-19 in rivers downstream of informal settlements, and in greywater run-off from these settlements

The SACCESS network can be thought of as an example of network governance which is defined as co-ordination between organisations characterised by an organic or informal social system.¹⁵ Networks and network governance have been theorised extensively. Network trajectories can be either serendipitous or goal-directed, with differing operational and structural dynamics.¹⁶ Whereas networks describe actors and the relational patterns between them, a governance perspective brings the question of whether and how these networks lead to network outcomes.¹⁷ Three modes of governance have been identified – participant-governed, lead organisation-governed, and network administrative organisation. Networks give preference to a mode depending on the level of trust; the number of participants; the extent of goal consensus; and the need for network-level competencies.¹⁸

There is a lack of understanding of informal networks¹⁹, particularly how newly inter-organisational collaborations take shape in the face of unexpected and harmful situations.²⁰ Berthod et al.²⁰ have suggested a preliminary model of inter-organisational assemblage in times of crisis, highlighting how actors who are not well known to one another are required to co-ordinate their activities quickly, but with limited knowledge of each other's skills, capabilities, motivations and communication practices. This study aimed to build on the theory of network governance, by exploring how the SACCESS network formed and developed during the public health emergency of COVID-19 to offer lessons for how such informal, intersectoral, bottom-up collaborations can contribute to health system strengthening.

Methodology

This study is an exploratory, single case study with the SACCESS network as the unit of focus. The SACCESS network comprises a diverse range of participants, including 32 organisations or departments and 72 individuals associated at some point with the network. We purposively chose 12 participants for interviews, each of whom represented the main organisations involved (including universities, research institutions, private laboratories local government and provincial health authorities) across diverse locations and settings in the country. Criteria for inclusion were that they were long-standing members of the network and regular participants in activities. Interviews were conducted over the period April to May 2021 and were transcribed and analysed thematically using reflexive thematic analysis.²¹ The use of theory, selection of cases to support analysis, member checking, and case contextualisation enhanced rigour.²² Ethical approval for this study was obtained from the University of Cape Town (UCT) Human Research Ethics Committee (HREC Reference No.: 211/2021).

Key findings

Thematic analysis of the data collected identified four main themes: 'factors that enabled network formation in the time of COVID-19'; 'the importance of relationships', 'strengths and challenges of an informal network', and 'lessons for building health systems'.

Network formation in the time of COVID-19: enabling factors

The SACCESS network was formed without any outside directive or single organisation leading the way. Instead, many interested parties were brought together through various routes to form the network serendipitously. The name and acronym for the network (SACCESS) was coined by one of the participants early on when the network members gave input to a joint proposal submitted through a national institution for funding. Participants spoke of the remarkable speed at which the network formed and accomplished tasks, due in part to the unique opportunity that COVID-19 presented. Several enabling factors emerged:

Scale of COVID -19

The pandemic affected *everyone*, which enabled practitioners in different disciplines to recognise the importance of working together to solve a problem:

[What] has been potentially unique about COVID-19 is it has affected everyone... It has been a major priority for all spheres of government, and an example of how different sectors need to respond to a health crisis. (Public health specialist)

The many unknowns in terms of COVID-19 made it crucial to work together. A common sense of urgency enabled the swiftness with which the network formed. COVID-19 removed some of the bureaucracy usually present, which not only allowed the network to form quickly, but also for processes to flow more easily.

A common problem

The network was formed based on the identification of a common problem. Sparked by international research, local members were united through a common goal. WW surveillance for COVID-19 was novel and lacked established methodology at the beginning of the outbreak. Participants were eager to connect, share ideas and help each other:

The network enabled scientists with similar research interests to connect in this research space, and it started organically with people sharing the invitation to the network meetings with other people also working in that similar field. (Senior scientist)

The pandemic was seen as an opportunity to improve research focus on WBE, and show its usefulness to people in wider roles.

Meeting online

The national network met fortnightly online with an open agenda. Having short meetings prevented the network from being a burden for members to participate. Becoming familiar with meeting via online platforms during the pandemic enabled connections to form more easily and rapidly than before:

A combination of the online environment and the urgency and common goal has meant that we have been able to speak to people where they would previously have needed... lots of trust-building and formal memorandums of understanding. (Public health specialist)

Importance of relationships

A common theme repeatedly highlighted was the importance of the relationships formed between members of the various organisations. Often, these connections were attributed to the individuals involved:

Big systems are just as strong as the working relationships between individuals who make it up. (Public health specialist)

New relationships are a benefit

Some participants mentioned having established connections with other members prior to the pandemic, but highlighted how the SACCESS network strengthened those bonds. Many participants saw the network as an opportunity to form connections with members they did not already know:

I saw some of the expertise in South Africa that I never even knew existed. (Senior manager)

A common issue at the beginning of the network formation was trust, but as the network developed:

[Members] became more open in sharing information because as time went on, you realise that these members of the network were not there because of selfish interest, they were there because of the good of the project. (Postdoctoral research fellow)

The opportunity to form these new connections resulted in more familiarity and relaxed engagement. It enabled communication between members even beyond the network, with members collaborating on other projects as well.

Interdisciplinarity is key

The interdisciplinary nature of the network was seen as essential, and having all the key players 'in the (virtual) room' helped to give credibility to the network.

Realising that there is no one individual that has all the answers... We can benefit properly only by all the different components, and all the different skills and expertise coming together. (Independent senior researcher)

Collaboration came from different disciplines, and the establishment of such a network has broadened members' perspectives and introduced an interdisciplinary way of thinking when addressing public health surveillance.

Potential for conflict

With having many different members involved, the potential for conflict among members did arise, particularly with regard to data-sharing. At first, there was no established data-sharing agreement, but as the network expanded, the need for one became more apparent. Diverse members of the network were generating new data, some of which were not yet well understood. A degree of conflict arose over the ownership and utilisation of the data:

It's always a tricky thing on how much do we want to share? But then other people could use it and do something and then you will not be first. But I think that the network has navigated that very nicely. (Virologist)

Some saw data-sharing as collaboration rather than competition. However, opinions on this point differed as other participants recognised the competition prevalent in the network:

We have institutions within the network that still see this as a competition that might compromise the opportunity but...if we are able to shift the barometer, there is more than enough in this pie for everyone to bite it. (Executive manager)

The issue of data-sharing was settled through a data-sharing agreement co-ordinated through the NICD, which collates and disseminates the data to the network. Individual organisations have published their findings, and the South African Medical Research Council (SAMRC) has a wastewater dashboard of results which is publicly available.

Other potential areas of conflict mentioned were competition for funding, and commercial threats.

If you have such an extensive network as this, it will always be difficult to make sure that everyone is involved and there are no conflicts. (Senior manager)

Strengths and challenges of an informal network

The network was described as collaborative, open and sharing. The network has developed over time from a more technical focus initially, to one of implementation of a monitoring programme that has national public health utility. To date, the network has no formal terms of reference or mission, but participants spoke of the network primarily as a learning and sharing platform to exchange knowledge and resources.

The role that research has played in the network was often mentioned by participants. Although not many formal research outputs have been published yet, members were able to learn and share from each other in a more

collaborative way in a field within which there were and still are many unknowns:

It is very important to share what everyone is doing because there is a lot of need still, and so many research questions we still have around wastewater surveillance, so [the network] is a fantastic opportunity to share the successes and challenges people are facing. (Senior scientist)

Informality as an advantage

The informality of the network was primarily seen as an advantage by participants, as the network arose out of need and members' willingness to participate.

The informality, and therefore the voluntary nature of participation, ensures that it is a collaboration of interested equals rather than a paternalistic, authoritarian approach. (Pathologist)

It was important for participants that the network could avoid hierarchy or domination by a single organisation, and that every contribution was recognised and respected equally. There was emphasis within the network on building local capacity and sustainability. In addition, the lessening of bureaucratic restrictions enabled the network to become active rapidly, rather than spending months formalising structures and processes. The lack of formality enabled flexibility as the network developed:

[It is] important to be agile, to change the aims or the scope of the network as things evolve and develop. (Senior scientist)

There was an open invitation to join the network; participants repeatedly highlighted the willingness of all parties to engage on the work, and how the informal structure allowed this. The network enabled participation of people who were committed and interested in the work, which created a readiness to share, give opinions, and assist:

That was the main driving force in the sense that we are not being asked or forced to join a group, or it was not one institution leading the charge per se, but individuals and people who were interested in the field. (Postdoctoral research fellow)

Challenges of informality

Particular challenges did arise within the SACCESS network. Some participants highlighted that the informality made it difficult to set timelines and goals. The lack of a co-ordinating body sometimes made it easy to lose sight of progress. Standardising analytical methodologies nationally has presented a challenge:

How we will consolidate information will be challenging because we [the laboratories] are all using different methods, and we have not yet standardised methods because the methods are fairly new... I think standardisation will also evolve as best practice becomes clearer. (Senior manager)

Participants pointed out that there were still many variables around the testing process that required a closer understanding. An additional challenge was that different members held different pieces of data, and it was often difficult to compile this information. Some organisations or groups of organisations also had their own separate projects. Although it was sometimes seen as advantageous that partners could pursue their own work-plans without much guidance, it was sometimes unclear as to what fell under the umbrella of the SACCESS network, and what did not.

A further challenge, particularly at the beginning of the network's evolution, was a lack of funding and additional resources, which some participants viewed as a hindrance in the process. Some funding has now been secured as the network attempts to expand to a national level under the guidance of the NICD. As one participant pointed out, perhaps this lack of funding initially inspired the willingness of members to share at the beginning of the pandemic:

Maybe not having loads of funding helped because it was not like we had any cash to offer anybody. (Public health specialist)

Among other challenges mentioned by participants were the informality of meetings and lack of meeting minutes, which sometimes made it difficult to keep abreast of developments. There was a need for collective handling of data, complicated by the existence of separate dashboards. Duplication of site selection among members required rationalisation, and the need to be more goal-oriented around the research component of the network was recognised.

Lessons for building the health system

Of interest was the variety of participants' opinions about the future of the SACCESS network. There is still some uncertainty around the utility of WW surveillance and how to promote it a useful public health tool. Some participants did not envision the network as having a long lifespan in a formal way. Participants generally agreed that the network would have to adapt over time:

In a year's time, the network will have to reinvent itself to some degree to decide whether we stay together. (Virologist)

Some participants envisioned the network expanding to combat future issues, and to survey other pathogens in WW. The relationships and connections established through the SACCESS network could be utilised beyond the pandemic:

To have a well-established network like this already in place... That is already a huge step ahead into tackling the next [public health emergency]... We have a group of scientists with understanding of who is capable of doing what. (Senior scientist)

Some participants saw the next step as a being towards the set-up of a more formal network, with the need for more

structure, funding, and an established research agenda. Some participants strongly envisioned establishing a national platform:

The ultimate goal is to establish a wastewater surveillance programme for the country... And the SACCESS network would bring in all the parties that would contribute to that monitoring. (Public health specialist)

Western Cape leading the way

During the initial development of the network, there was a strong WC bias, particularly within the City of Cape Town. The WC was the first to establish a provincial WW surveillance network. WC has a strong regional network and is currently contributing weekly data on WW to various surveillance activities throughout the province. This has been attributed primarily to the strong linkages and relationships between organisations in the WC. There is solid collaboration of expertise between academic institutions, research councils, and different spheres of provincial government, all in a small radius around Cape Town.

These connections and links to government are not present in other provinces. WC was seen to be leading the way in WW surveillance. This was attributed to the individuals involved, rather than the institutions. The importance of having champions in the WC was highlighted, particularly those in dual positions (e.g. linked to both the Provincial Department of Health and academic institutions):

Having a champion is important, so having one or two people who are committed and prepared to drive it... We might have all fallen apart if it was not for [them] keeping it all going and keeping us all connected. (Public health specialist)

Although the WC network was highly commended by participants, it was also pointed out by participants that the WC bias of the whole network was not inclusive or diverse enough.

We have got one or two comments that say... We feel a bit marginalised in the whole process because they are able to talk their language and then, we do not get a chance in that process as well. (Executive manager)

Expanding the network

Participants highlighted the lack of buy-in from government at municipal, provincial, and national levels as a challenge in the network. This poses the question:

From the lessons learnt from the [WC] regional perspective, how can this be expanded to the national level? (Postdoctoral research fellow)

Provincial Departments of Health outside the WC and some municipalities were seen to lack understanding of the utility of the work, and did not have exposure. Although members of

the local government association, SALGA, have been invited to meetings, engagement with municipalities seems to be limited. Participants felt that this would have to be overcome for the success of a national network to be achieved.

Some participants thought the government could have utilised the network and the information it provided more effectively during the pandemic:

I was frustrated that the government did not respond, they could have used the SACCESS network a lot better to respond to the second wave, and they should use it for the third wave that is coming as well. (Senior manager)

However, other participants with more established connections with national stakeholders thought that the data were not yet meaningful enough to support national public health utility:

It has been too early really to actually make this matrix [of connections in government] because of our technical issues around getting quantitative results... I think we have not had information that will be meaningful for them yet which is why we have not actively pursued that arm of it. (Senior manager)

However, despite these uncertainties, participants believed WW surveillance to be an underutilised tool which could play an important supplementary role in COVID-19 surveillance and beyond.

If collectively we are able to shift the barometer of government to [recognise] we are doing some great work in this area, they can start mainstreaming and funding it with the right amount of momentum. (Executive manager)

Conclusions and recommendations

This case study utilised interviews with key informants to provide understanding of the strengths and challenges emerging from the SACCESS network as an example of network governance. The scope of this study was limited, but further understanding of this phenomenon would benefit from a social network analysis. Collection of more ethnographic data or utilisation of a participant observation approach would be beneficial for researchers to gain a more refined view of the complexities of the network, and possibly to decrease recall bias. In addition, this case study focused explicitly on a relatively small network in South Africa, so the generalisability of these findings should be taken with caution. However, these findings are similar to emerging research on WW surveillance in college campuses in the United States of America (USA).²³ The importance of collaborations was highlighted in both studies, as the networks presented opportunities for partnership and research beyond members' usual scope

of work. In both cases, communication helped to create successful workflows.²³

Further key potential lessons can be drawn with regard to the SACCESS network. As presented in the following summary, these should be seen as recommendations for further areas of investigation and research.

Lessons for health system strengthening in the time of COVID-19 and beyond

Seven key lessons, drawn from the example of the SACCESS network, are summarised in Figure 1 which highlights the importance of networks in public health emergencies and beyond.

Figure 1: Key lessons from the SACCESS network



As a network evolves, network governance can be flexible

Building on the theory of network governance and inter-organisational assemblage in times of crisis, several points can be drawn from the SACCESS network. The SACCESS network has qualities of both a serendipitous and a goal-

directed network.¹⁶ Although it formed in a serendipitous manner and has no formal terms of reference or mission, it can be argued that the network was still goal-directed with the aim of establishing WW surveillance across the country. The network's mode of governance began as a shared governance, or participant-based structure.¹⁸ However, as

the network evolves under the co-ordination of the NICD, there is a possibility of it shifting to a 'lead organisation', or 'network administrative organisation' mode of governance. This is also seen in the literature, as networks often move from a non-brokered to a brokered governance mode as they mature or increase in size.¹⁸

The SACCESS network's trajectory and mode of governance are clearly evolving and flexible. Not only does this indicate that networks can be flexible, but also that flexibility was crucial for enabling the SACCESS network to achieve what it did. This is similar to findings in the USA which highlighted that adaptation, collaboration and learning were key in finding innovative solutions to local challenges.²³ It is also important to note that this would not have happened without the COVID-19 pandemic emergency. The agility of the network in combination with the crisis of COVID-19 enabled SACCESS to be formed and to respond to challenges in a short space of time.

An informal network may find difficulty in expanding and interacting with formal, bureaucratic structures

As noted, the informality of the network was key in its success. However, challenges have arisen through interactions with more formal, bureaucratic structures such as municipalities, Provincial Departments of Health, and national government. As the SACCESS network is still evolving, one cannot predict its path. However, to scale up, gain buy-in from formalised government structures, and open opportunities for more sustainable stewardship from national institutions, the network may have to become more formalised. Stewardship provided by the NICD and other agencies has the potential to assist in long-term sustainability of such networks. At the same time, in that process, the network may lose some of the qualities that enabled its rapid achievements. The interaction between informal networks and more formal, bureaucratic structures remains a challenge²⁴ because the very nature of bureaucratic structures excludes and delegitimises the importance of informal structures.²⁴ However, it is crucial that both exist and we should be mindful of the value of informal networks, recognise their role, and create space for them in our health system.

One example of how the SACCESS network achieved success in its interactions with local government occurred in the WC. The early success in the WC was attributed to the strength of existing individual connections between different spheres of government, academic institutions and research councils, although the NICD is also gradually building relationships with local municipalities in other provinces. The importance of connections between individuals rather than institutions was highlighted in this example, as well as in the national network. The role that individuals can play in creating informal networks and their rapid success should be recognised. Informal networks, and the individuals involved, should be utilised as a key component of health system strengthening and responsiveness to public health emergencies and beyond.

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